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TOWARDS A MODEL OF PROCESS-MODELLING PRACTICE: QUANTITATIVE VALIDATION AND RESULTS

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Abstract

The paper revises an existing model of process-modelling practice and uses it in a survey of Norwegian model-based process-change projects. A central hypothesis is confirmed: There is a positive relationship between modelling processes in terms of management support, lack of resistance, in-project training, model types, and project outcome. Further work should improve instrument validity and the research model by including other organisational and social dimensions of process-modelling behaviour and effects.

Keywords: Process modelling, process-modelling practice model, business process management, enterprise modelling,

1 BACKGROUND

Process modelling (Curtis et al. 1992) is important for business process management (BPM) (Harmon 2003, Hillier 2005, Smith & Fingar 2003). However, the first publications on process change (Hammer 1990, Hammer & Champy 1993, Davenport 1993) did not emphasize process modelling, considering it merely as a useful technique. Since then, a number of modelling techniques and tools have been proposed. Process models are commonly used to document existing practice, analyse this practice and suggest future improvements. Process models are also used for structuring the vast amount of information that materialises in process-change projects.

Despite this, there are few theories and empirical studies available to guide practice of and research on process-modelling. The purpose of this paper is to revise and empirically test the Process-Modelling Practice model. The revised PMP model focuses on how *Modelling processes* and *Process competence* are related to the *Outcome* of model-based process-change projects. Each of these three *main variables* (or *first order, multi-dimensional constructs*) are further decomposed into *dimensions* (or *second order constructs*) as described in Section 3.

The next section presents theory of process change and development of the a priori process-modelling practice model, whereas Section 3 presents the revised research model and our hypotheses. Section 4 then describes the research design, before Section 5 presents our results. Finally, Section 6 discusses the results and offers paths for further work.

2 THEORY

2.1 Empirical studies of process modelling

There is a relative scarcity of empirically-based theories and models of process-modelling practice. Some studies have surveyed process modelling users and report on the utility of process modelling. Iden's (1995) interviewed of BPR-consultants, finding that they were not well acquainted with available process-modelling techniques and tools. Kueng and Kawalek (1997) interviewed participants in process modelling projects, reporting that process models were considered very useful for facilitating communication between users and IT experts. Other examples of surveys include Kesari et al. (2003) and Wietzel et al. (2006).

Other studies report on case studies of process modelling in enterprises. Dalberg, Jensen & Krogstie (2005) studied how enterprise modelling – and, more specifically, process modelling – was used in different parts of an engineering organisation. Other examples include Karltun et al. (1999), Djohan et al. (2002), Mendes et al. (2003), Brain et al. (2005) and Becker et al. (2007). A third group of studies develop theories of process modelling, including the Process-Modeling Success model (e.g., Rosemann et al. 2001, Chan & Rosemann 2002, Sedera et al. 2002, 2003, 2004, Bandara et al. 2005a, 2005b, 2006) and the authors' Process-Modelling Practice (PMP) model (Iden et al. 2006, Iden et al. 2007, Eikebrokk et al. 2008).

2.2 The Process-Modeling Success Model

Sedera et al's (2003, 2004) Process-Modeling Success (PM-Success) model has two main variables: *critical success factors* and *success measures*. The critical success factors are divided into *project-specific* and *modelling-related* factors. Project-specific success factors are *stakeholder participation* (degree of input from process roles), *management support* (level of commitment by senior management), *information resources* (resources available to inform the modelling project.), *process management* (management of the process modelling project), and *modeller's expertise* (experiences of the process modellers). Modelling-related success factors are *modelling methodology* (instructions for the process of modelling), *modelling languages* (grammar or the syntactic rules), and *modelling tool* (software that facilitates design, maintenance and distribution of process models).

2.3 The Process-Modelling Practice Model

The Process-Modelling Practice (PMP) model (Iden et al. 2006, Iden et al. 2007, Eikebrokk et al. 2008) aims at describing *model-based process-change projects*. The scarcity of available theories and instruments at the time (2004), made us take an explorative approach to complement the emerging PM-Success. Our Norwegian context is characterised by high worker involvement (e.g. worker representation in executive boards mandated by law) and low power distance (Hofstede, 1997), we emphasised *organisational and social aspects* in our model. We included *competence* and *learning* as prerequisites for and consequences of process modelling. Development and validation of the PMP model is described in detail in (Eikebrokk et al. 2008). We first developed an *a priori model* based on a review of empirical studies of process-modelling projects, review of appropriate theory, considerations about the Norwegian cultural context and the researchers' experiences from participating in numerous process- and enterprise-modelling projects.

The a priori PMP model (Figure 1) has two central variables: *Modelling process* and *Model artefact,* reflecting the activity-artefact dichotomy emphasised by many IS authors, e.g., Floyd (1999), and in Activity Theory (Vygotsky 1986, Engeström 1999). Their relevance is corroborated by Dalberg et al's (2005) central distinction between modelling and models, and the distinction in the PM-Success model between *project-specific* and *modelling-related* factors. We selected a set of candidate issues from the literature for use in our interview guide, since no developed instruments existed for either variable at the time. We systematically assessed the relevant dimensions of the Process Model Success Model and supplemented them by adapting ideas from the Technology Acceptance Model (Davis 1989) and the IS Success Model (De Lone and McLean 1992, 2003). The resulting issues were grounded in literature, practical experience or data from the pilot interviews.

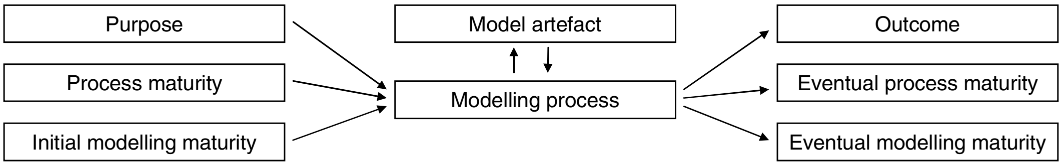

Figure 1. The a priori Process-Modelling Practice (PMP) model (Iden et al. 2006).

The a priori PMP model introduced *Purpose* as a variable that referred to the anticipated outcomes of process modelling, consistent with theories that emphasize the *intentionality* of human activity (e.g., Vygotsky, 1986), and open for purposes not described in the literature. The model separated the *intended artefacts produced* from the *intended effects of process modellin*, consistent with the project-management literature (e.g., Andersen et al. 2004, Frame 1995). *Outcome* was introduced as a dependent variable, subdivided into *attainment of purpose* and the *actual effect of process modelling* on processes. The *Purpose* and *Outcome* variables are consistent with Dalberg et al's (2005) process model value model.

Competence and *learning* are inspired by the Capability Maturity Model (Paulk et al. 1993). The a priori PMP model included *process* and *process-modelling maturity*, inspired by the maturity levels in the original CMM. Organisational learning was included through *initial* and *eventual maturities*, i.e., changes in *process* or *process-modelling maturity* resulting from the process change project. We expected particular types of *Modelling purpose*, along with an organisation's *Initial process* and *process-modelling maturities*, to be associated with particular types of *Modelling processes*. Particular types of *Modelling processes* were expected to produce and use particular types of *Model artefacts*. Together, we expected particular types of modelling processes and model artefacts to be associated with particular *Outcomes* and produce the organisation's *Eventual process* and *modelling maturity*.

We developed a semi-structured *interview guide*, which was iteratively improved through 8 pilot interviews. The research model and interview guide were then *initially validated* in a study of 34 projects (Eikebrokk et al. 2008). The results indicated that several aspects of the *Modelling process* were positively related to *Outcome*. The study was not able to establish the importance of the *Model artefact*.

3 RESEARCH MODEL AND HYPOTHESES

3.1 Revising the Process-Modelling Practice Model

Based on the initial validation (Eikebrokk et al. 2008), the a priori PMP model was revised (Figure 2). Each top-level construct was multi-dimensional, i.e., formed by multiple dimensions. The revised model includes *Process competence*, defined as "the organisation's ability to manage, model and improve its processes." *Process competence* is reflected in the following two dimensions: *Process-orientation competence* reflects the organisation's ability to manage and improve its processes independently of model use, corresponding to *Initial process maturity* in the inital model. *Process-modelling competence* reflects the organisation's ability to model its processes and effectively using the resulting models, corresponding to *Initial process-modelling maturity* in Figure 1. The revised model retains the *Modelling process* construct, defined as "the activities carried out within the project to improve the organisation's processes." The following constructs from the initial study were included as dimensions of *Modelling process*: *Employee participation, Management support, In-project training, Lack of resistance, Model type*.

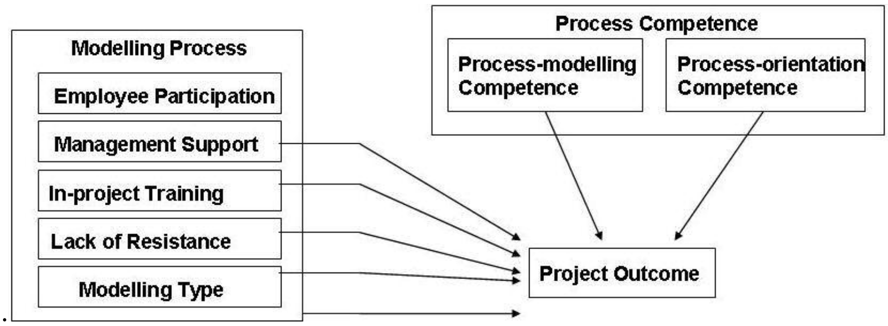

Figure 2. The revised Process-Modelling Practice (PMP) model.

Finally, *Project outcome* is defined as "the results of the project to the organisation, including achievement of project goals and effected organisational changes and learning." *Project outcome* consists of the following dimensions: *Goal achievement* describes the extent to which the project met the goals that were set at its initiation. *Organisational impact* reflects the extent to which the process was changed after the project, using known criteria from the literature. This is a formative dimension, which covers the types of effects that were most prominent in the initial study. *Process-orientation learning* describes to what extent the organisation and its people have increased their competencies in process orientation. *Process-modelling learning* describes to what extent competencies in process modelling have increased.

3.2 Hypotheses

In the revised model, *Process competence* and *Modelling process* are considered independent variables determining the dependent variable *Project outcome*. The causal effect of *Modelling process* on *Project outcome* reflects relationships in the initial model that were validated in the initial study. The causal effect of *Process competence* on *Project outcome* differs from the initial model, where the relationship between initial maturities and outcome was *indirect* through the modelling-process construct. The initial study found some indications of direct effects of competence on outcome and eventual maturity, explaining the revision of the model. In each case, the direction of causality can be justified by a temporal precedence: *Process competence* reflects the state of the organisation *before* the *Modelling process* was initiated, whereas *Project outcome* reflects the organisation's state *after* the *Modelling process*.

	Hypotheses
H1	Modelling process is positively related to project outcome
H1.1	Management support is positively related to project outcome
H1.2	Employee participation is positively related to project outcome
H1.3	In-project training is positively related to project outcome
H1.4	Presence of resistance is positively related to project outcome
H1.5	Model type is positively related to project outcome
H2	Competence in process orientation and process modelling is positively related to modelling process
H2.1	Competence in process orientation is positively related to project outcome
H2.2	Competence in process modelling is positively related to modelling process

Table 1. Hypotheses derived from the relationships in Figure 2.

We state hypotheses both at the top-level between the three multi-dimensional constructs and at the decomposed level, between their dimensions. Following Petter et al. (2007), if it is possible to show that both the (first order) variables and (second order) dimensions are related, analysing both levels gives the most complete and accurate picture. Nine hypotheses were derived, as shown in Table 1, with each hypothesis corresponding to a relation between two main variables or dimensions in Figure 2. Each hypothesis rested on the assumption that higher *Process competence* and more elaborate *Modelling processes* cause more extensive *Project outcome*. As a single exception, we hypothesised that *more* resistance leads to more extensive project outcome, a somewhat surprising assumption suggested by the initial study and discussed further by the authors in (Iden et al. 2007).

4 RESEARCH METHODS

4.1 Research design

To test our research model and hypotheses, we conducted a cross-sectional field study with individual model-based process-change projects as the level of analysis. A questionnaire was administered by regular mail to a selection of Norwegian enterprises in June 2007, targeting personnel who had been actively involved in one or more process-development projects, e.g. quality managers, process owners, IT managers, process developers, system developers and consultants. We used available address lists of the participants at a national industrial IT conference, the largest enterprises in western Norway and the members of a regional interest group for process development. In total, 460 questionnaires were administered. The informants were asked to answer the questionnaire based on a self-chosen project in which they had been involved during the past 5 years.

4.2 Operationalisations and measurements

We operationalised the theoretical constructs in the refined research model (Figure 2) based on questions from the interview guide for the initial validation. The resulting survey instrument (http://is.uib.no/wiki/Papers/Ecis08) comprised 69 questions. Indicators of the dimensions of *Modelling process* (21 indicators), *Process competence* (8 indicators) and *Project outcome* (17 indicators) were measured using response formats of a 5-point Likert-type scale, with three-to-six indicators for each dimension. There were exceptions for two of the formative dimensions of *Modelling process*: *Management support* comprised a pair of multiple-choice indicators, and *Employee participation* was operationalised by combining a multiple-choice indicator with three Likert-type indicators. By combining information from these indicators, the resulting indicators for these variables were created as new ordinal inidicatons. In addition, the survey instrument controlled for the *Context* of the project, organisation and individual informant (18 questions). The *Individual context* describes central characteristics of the informant. The *Project context* describes the project from which the informant responds, including its *Purpose*. The *Organisational context* describes the setting for the project.

5 RESULTS

5.1 Responses

We received 90 responses, giving a response rate of 19.6%. On average, the respondents had worked with process improvement for 5 years and process modelling for 3 years. The largest respondent groups were process developers and external consultants, along with IT managers, consultants, quality managers and department heads. Organisations in the public and IT sectors provided most responses. We also received many responses from organisations in telecom and media, bank and finance and private services. Organisation sizes ranged from 12 to 18.000 employees, with an average of 2343. Project sizes ranged from 4 to 350 people involved, with an average of 29. Within the project they reported from, most respondents had acted as project leaders, process developers (facilitators) and process modellers. Other common roles were department manager, IT advisor, role representative and external consultant. After measurement validation from several stages of interviews, described earlier, content validity was assessed and improved (Straub et al. 2004).

5.2 Construct validity

Construct validity was assessed in terms of discriminant and convergent validity in a two-step procedure. The first step assessed discriminant validity through an exploratory factor analysis. We regarded this exploratory approach as sufficient at this stage because of the early stage of theory development and the likelihood that characteristics of our research context was not described in theory. The next step assessed convergent validity in terms of coefficient alpha of the set of indicators within each dimension. See Appendix 2 for an overview of the variables, their reliability and retained indicators. All the dimensions measured using reflective indicators and Likert-type scales were included in the factor analysis. *Management support* and *Employee participation* were included, after transforming the three multiple-choice indicators into ordinal scales (1-6, 1-13 and 1-4, respectively). As a result, the factor analysis covered 42 indicators. The scores for all indicators were normalised into the 0-1 range.

Factors were extracted from the normalised indicators for all 90 respondents using Principal Component Analysis and Varimax-rotated using Kaiser Normalisation. Analysis was iterative, with indicators dropped in each iteration according to the following criteria: All items were dropped that did not load on the same factor as the other indicators in the same dimension. Also, all items were dropped that loaded on multiple factors. In the end, 33 indicators remained, as shown in Appendix 1. In this final rotated matrix, all factor loadings were > 0.5, described by Hair et al. (2006) as "very significant". 4 out of the 33 indicators had loadings that were between .2 and .3 grater than the second highest loading. 7 out of the remaining 29 indicators had loadings that were between .3 and .4 above the second highest loading. All of the remaining 22 indicators loaded only on one factor. Cumulatively, the 7 factors explained 72.6 of total variance in the 33 indicators.

Appendix 1 shows that the *reflective indicators* (indicators EC2, EC3, P1, P3 and P4 in Appendix 1 and 2) all loaded on different factors, each relating back to a different dimension in Figure 2. Indicator P5 (*Model type)* in Appendix 1 also loaded on factors that were distinct from the other dimensions, but this indicator loaded on three *different* factors. This is acceptable, as P5 is a *formative indicator* that combines multiple underlying factors. All four dimensions of *Project outcome* loaded onto the same distinct factor, and *Project outcome* was therefore treated as a uni-dimensional variable in the rest of the analysis.

The final measure for each variable was calculated as an index based on the retained indicators, weighing the contribution of each indicator to its dimension with the indicator's component scores from Appendix 1. Cronbach's Alpha's were then calculated for all the revised measurement scales containing reflective indicators. All Alphas were above 0.8 for the reflective indicators, indicating sufficient convergent validity/reliability for our explorative, validation study. Appendix 2 provides an overview of the variables used, their reliabilities as well as the final indicators used in their measurement.

5.3 Hypotheses Test

Pearson's correlations were chosen to test our hypotheses. Pearson's correlation assumes normally distributed data and measurements at the ratio or interval level. Kolmogorov-Smirnov tests confirmed that the two main indices *Modelling process* and *Project outcome* were normally distributed, as were the indicators P1 (*Management support*) and P4 (*Lack of resistance*) in Appendix 1 and 2. On the other hand, indicators CE2, CE3, P3 and P5 were not normally distributed and should be used with some caution. Also, the Likert-type measurement scales with 5 response categories used deviate from the assumptions behind Pearson's correlation. However, simulation studies have documented that Likert-type scales with 5 or more response categories are similar to measurements at the ratio or interval level, thus suitable for Pearson's correlation (e.g., Johnson and Creech, 1983).

Five of eight hypotheses were supported as shown in Figure 3, which shows that *Management support*, *In-project training*, *Lack of resistance* and *Model type* are all significantly correlated to *Project outcome*. All indicators for *Employee participation* had to be dropped during factor analysis, so this variable could not be considered further in the analysis. No significant correlations were found from *Process competence* or its two dimensions to *Project outcome*.

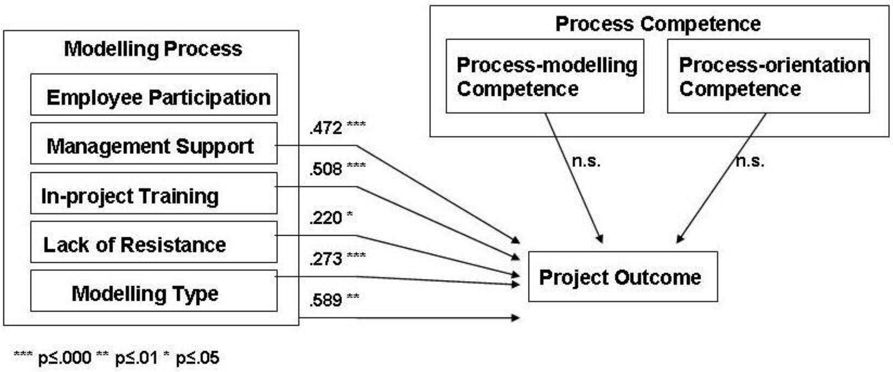

Figure 3. One-tailed Pearson's correlations.

	Hypotheses	Results
H1	Modelling process is positively related to project outcome	p ≤ 0.000
H1.1	Management support is positively related to project outcome	p ≤ 0.000
H1.2	Employee participation is positively related to project outcome	-
H1.3	In-project training is positively related to project outcome	p ≤ 0.000
H1.4	*Lack of* resistance is positively related to project outcome	p ≤ 0.028
H1.5	Model type is positively related to project outcome	p ≤ 0.009
H2	Competence in process orientation and process modelling is positively related to modelling process	n.s.
H2.1	Competence in process orientation is positively related to project outcome	n.s.
H2.2	Competence in process modelling is positively related to modelling process	n.s.

Table 2. The results of testing the main hypotheses in Table 1.

6 DISCUSSION AND CONCLUSION

The paper has revised a model of process-modelling practice developed in an earlier study and tested it empirically in a survey of Norwegian model-based process-change projects. A central hypothesis was confirmed: A positive correlation exists between *Modelling processes* and *Project outcome*. The other central hypothesis could not be confirmed that higher organisational *Process competence* is positively correlated to *Project outcome*. There is a scarcity of theories and instruments on process modelling practice. Therefore our research is exploratory in nature, albeit informed by existing literature.

The implications for practice are straightforward. Both *Management support* and *In-project training* are critical for effective model-based process-change projects. An organisational culture and project-execution strategy that avoids and defuses *resistance* is also beneficial. Furthermore, there is a benefit in using more elaborate models, modelling techniques and tools, as evidenced by the signifcant correlation between *Model type* and *Project outcome*. The study thereby validates the dimensions of our *Modelling process variable* (except for the *Employee participation* dimension, which had to be dropped after factor analysis).

Surprisingly, *Process competence* was not related to *Project outcome*. Possible explanations are low content validity of the instrument and that *Process modelling* can be used effectively by organisations with or without *Process competence.* A third explanation is that most organisations with high *Process competence* will already have reaped the largest benefits from past process-change projects, resulting in diminishing returns on further projects.

The study has several methodological limitations. Sample size was low, the sample was convenient and the response rate low (< 20%). The survey instrument needs to be further refined and validated with data from other contexts and by other researchers. For example, none of the indicators for *Employee participation* and only one indicator for *In-project training* was retained after factor analysis. Better measurements for these dimensions need to be addressed by further work. The correlation analysis should also be supplemented by second generation statistical analysis, using structural equation modelling (SEM). Our findings are primarily generalisable to SMEs and to the Nordic cultural sphere. Further studies are needed to improve the external validity of our findings. Cross-national studies could even investigate the impacts of differences in national culture on process-development projects, along the lines of (Iden et al. 2006). Cross-cultural aspects of process development and process modelling will become increasingly important in the global economy.

Our analysis indicates that the outcome of model-based process-change projects is explained by a combination of technological (i.e., *Model type*), social (i.e., *Lack of resistance*), organisational (i.e., *Management support*) factors. But the present study cannot exclude the importance of additional dimensions of *Modelling process*. For example, further studies should investigate the effects of *resources*, i.e., whether adequate resources were available for carrying out the project. Also, *Lack of resistance* is only weakly (albeit significantly) related to outcome. The research model should therefore investigate the effects of *organisational culture* (Brown 1998) in a broader sense. The relation of *Model type* to *Project outcome* is also weak (though significant), so *Model type* might exploratively be split into several dimensions. The re-specified Process-Modeling Success (PM-Success) model (Bandara et al. 2005a) distinguishes between *modelling methodology*, *modelling language* and *modelling tool*. However, our initial study did not provide support for such detailed dimensions of *Model artefact* having an impact on *Outcome.* A possible explanation is that, unlike the PM-Success model, our measure of *Project outcome* does not include *Model quality* as a dimension of the dependent variable.

Now that the PM-Success model has been finalised (Bandara et al. 2006), it is possible to compare the two with the aim to improve the research models and share instruments. Besides differences in model artefacts, both models confirm the importance of *Management support.* The significance of *Employee participation* could not be validated in the study. The PMP model emphasises *Lack of resistance* and *In-project training*, whereas the PM-Success model emphasises *Information resources* and *Project management*. Further studies should seek to increase content validity of the PMP model's *Process modelling* variable by including dimensions from the PM-Success model. Further studies should also seek to increase instrument reliability and validity by adopting and adapting some of the PM-Success model's measures.

On the depenent-variable side, our *Project outcome* variable resembles the *PM-Success measure* (Bandara et al. 2006) in that they both distinguish *attainment of purpose* (*Goal achievement* in our study, *Process efficiency* in the PM-Success measure) from the *actual effect of process modelling* on processes (*Organisational impact* in our study, *Process impacts* in the PM-Success measure).

The match between the two pairs of dimensions is not exact. The items in the PMP model tend to be spread more broadly, as reflected by the lower Cronbach's alpha values they produce. Unlike the PMP model, the PM-Success model does not address organisational learning. On the other hand, Bandara et al. (2006) include *Model quality* in their success measure. It is not clear that model quality is a dimension of the dependent rather than the independent variable. Indeed, different process-change projects may develop models of various quality depending on context, and a model of such projects should be able to predict the consequences of choosing a higher or lower quality model on project outcome. For this purpose, in terms of the PMP model, we therefore argue that process-model quality should be a dimension of *Modelling process* and not of *Project outcome*.

Further comparing and combining elements from the PMP and the PM-Success models is a promising research path. Research based on the Theory of Reasoned Action (Fishbein & Ajzen 1975) and the Theory of Planned Behaviour (Ajzen 1991) illustrates how additional technological, social and organisational perspectives could be included in behavioural models. Now that the PMP model has been empirically validated, it is time to revisit some of the existing theories and instruments such as the Technology Acceptance Model (Davis 1989), IS Success Model (De Lone & McLean 1992, 2003) and Capability Maturity Model (Paulk et al. 1993).

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APPENDIX 1. FACTOR ANALYSIS RESULTS

	Factor								
	1	2	3	4	5	6	7	8	9
Process Competence (EC2) EC2a: processes described and standardised		,419	,736						
EC2b: process ownership well established			,794						
EC2c: explicit process goals			,754						
EC2d: systematic monitoring of goals		,415	,646						
Process Modelling Competence (EC3) EC3a: process modelling much used		,720	,339						
EC3b: standard modelling notation established		,829							
EC3c: process models much used		,817							
EC3d: process models kept up-to-date		,777							
Management Support (P1) P1a: explicit top management support					,637	,424			
P1b: top management participated in modelling					,919				
P1c: top management actively followed-up	,349		,310		,771				
In-project training (P3) P3a: adequate process training offered							,872		
Lack of Resistance (P4*) P4a: employee resistance to process modelling				,821					
P4b: top management resistance to proc. modelling				,847					
P4c: resistance has reduced organisational effects				,731			,425		
P4d: resistance has reduced project results				,729			,452		
Modelling Technique (P5) P5a: well-defined process model notation						,693			
P5b: explicit models of current situation								,896	
P5c: explicit models of future situation	,334								,761
P5d: swimlanes to show actors/roles	,322					,674			
Goal Achievement (O1) O1a: project has improved the processes	,793								
O1b: planned deliverables produced	,699								
O1c: project effect goals achieved	,556							,333	
Process Change (O2) O2a: processes described and standardised	,752								
O2b: process ownership well established	,763								
O2c: explicit process goals	,704								
Process Use (O3) O3a: process modelling much used	,736								
O3c: process models much used	,756								
O3d: process models kept up-to-date	,693								
Organisational Changes (O4). O4a: productivity gains	,697					-,356			,332
O4b: quality improvement	,818								

O4c: increased efficiency	,749					-,363			
O4d: clearer responsibility distribution	,689								

Extraction Method: Principal Component Analysis. Varimax rotation with Kaiser Normalization converged in 9 iterations.

APPENDIX 2. INDICATORS USED IN THE FINAL ANALYSIS

Process Competence (EC2). Scale reliability (Coeff. alpha): 0.81

EC2a: Before the project, processes were described and standardised in the enterprise

EC2b: Before the project, process ownership was well established in the enterprise

EC2c: Before the project, explicit process goals were set in the enterprise

EC2d: Before the project, the goal achievement for the enterprise's processes was systematically monitored

Process Modelling Competence (EC3). Scale reliability (Coeff. alpha): 0.82

EC3a: Before the project, process modelling was much used in the enterprise

EC3b: Before the project, a standard modelling notation was well established in the enterprise

EC3c: Before the project, the enterprise's process models were much used

EC3d: Before the project, one kept the enterprise's process models up-to-date whenever the organisation changed

Management Support (P1). Scale reliability (Coeff. alpha): 0.83

P1a: Top management has explicitly expressed to the whole enterprise that process modelling was important

P1b: Top management have participated actively in the process modelling

P1c: Top management have actively followed-up the process modelling during the project

In-project training (P3). Scale reliability (Coeff. alpha): -

P3a: Adequate training in process orientation was offered in relation to the project

Lack of Resistance (P4*). Scale reliability (Coeff. alpha): 0.85

P4a: There has been expressions of resistance to process modelling from affected employees

P4b There has been expressions of resistance to process modelling from affected top managers

P4c: Resistance has made the project have more limited effect on the organisation than planned

P4d: Resistance has made the project deliver more limited results than planned

Modelling Technique (P5). Scale reliability (Coeff. alpha): 0.54

P5a: The project used a well-defined (standard or own) process-modelling notation

P5b: The project modelled the current situation explicitly for each process

P5c: The project modelled the future situation explicitly for each process

P5d: The project used 'swimlanes' to show process actors/roles

Goal Achievement (O1). Scale reliability (Coeff. alpha): 0.75

O1a: The enterprise's process have been improved because of the project

O1b: The planned deliverables have been produced

O1c: The project effect goals set for the project have been achieved

Process Change (O2). Scale reliability (Coeff. alpha): 0.84

O2a: Because of the project, processes are described and standardised in the enterprise today

O2b: Because of the project, process ownership is well established in the enterprise today

O2c: Because of the project, explicit process goals are set in the enterprise today

Process Use (O3). Scale reliability (Coeff. alpha): 0.87

O3a: Because of the project, process modelling is much used in the enterprise today

O3c: Because of the project, the enterprise's process models are much used today

O3d: Because of the project, one keeps the enterprise's process models up-to-date whenever the organisation changes

Organisational Changes (O4). Scale reliability (Coeff. alpha): 0.84

O4a: Because of the project, one has achieved productivity gains

O4b: Because of the project, one has achieved quality improvement

O4c: Because of the project, one has achieved increased efficiency

O4d: Because of the project, one has achieved clearer responsibility distribution